Remarks

Amendments to the Claims

Independent claim 1 has been amended to state that a first portion of particles of a hydride are reacted with a chemically equivalent quantity of water to produce heat in a first reaction. As disclosed in the specification at paragraph 0081 (0105 in published application) the reaction is spontaneous and exothermic. The water is consumed. The heat is employed to initiate a reaction between a mixture of a second portion of hydride particles with particles of a hydroxide (as disclosed, for example, in paragraphs 0025, 0052, 0063, 0087, and 0088 of the application; paragraphs 0025, 0067, 0090, 0114, and 0115 of the published application). Both reactions produce hydrogen gas.

As disclosed in paragraph 0084 (0112 of the published application), it is preferred that substantially chemical equivalent quantities of hydride and hydroxide are used so that the reactants are consumed to an industrially practical level, expected by one skilled in the art. This increases the volumetric and weight efficiency of the hydrogen storage materials and the methods of their usage.

Independent claim 67 has been amended to state that the first reaction is between water and particles of a hydride. The heat of the first reaction is used to induce a second reaction in the solid state between particles of the hydride mixed with particles of a hydroxide to yield hydrogen gas and an oxide. Apart from the water and hydrogen product, solid constituents are used in the claimed method for producing hydrogen.

Independent Claim 72 is directed to an embodiment of the invention disclosed in paragraphs 0088-0090 (publication paragraphs 0112, 0116-0119). Claim 72 has been amended to state that in its hydrogenated state, the hydrogen storage composition comprises a mixture of particles of a hydride and a hydrated hydroxide, the quantity of the hydride being substantially chemically equivalent to the hydroxide and hydrated hydroxide for a solid-state reaction to produce hydrogen gas and an oxide. As disclosed the amount of hydride particles are to be sufficient to react with the water of crystallization of the hydroxide, the hydroxide formed by reaction of a portion of the hydride with such water, and the original hydroxide.

The independent claims provide species of materials and practices for conduct of the claimed methods.

The Claim rejections under 35 U.S.C. 102(e) and 103(a)

Claims 1-12, 14-18, 48, 49, 67-71 are rejected under 35 U.S.C. 102(e) as anticipated by or in the alternative, under 35 U.S.C. 103(a) as obvious over Amendola et al. (U.S. 2004/0033194). It is respectfully requested that each of these rejections be reconsidered and withdrawn for the reasons given below in this paper.

The Claim rejections under 35 U.S.C. 103(a)

Claims 26-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Amendola et al. (U.S. 2004/0033194) in view of Chen et al. (U.S. 6471936).

Claims 19-25, 54-55, 61, 63-66, 72-81 are rejected under 35 U.S.C. 103(a) as being unpatentable over Amendola et al. (U.S. 2004/0033194) in view of either Machin et al. ("Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride") or Long et al. (U.S. 5593640).

Claims 57, 82, and 84 are rejected under 35 U.S.C. 103(a) as being unpatentable over Amendola et al. (U.S. 2004/0033194) in view of Chen et al. (U.S. 6471936) and either Machin et al. ("Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride") or Long et al. (U.S. 5593640).

It is respectfully requested that each of these rejections be reconsidered and withdrawn for the reasons given below in this paper.

The Patentability of the Claims under Prosecution.

The Claimed Invention

The claimed methods provide highly efficient solid-state reactions between hydrides and hydroxides for the production of hydrogen gas. The reactions between mixed particles of hydrides and hydroxides are promoted by a first reaction between water and a portion of the hydride particles. The water is consumed in this practice and further reaction of hydride particles with hydroxide particles is in the solid state which contributes to the volumetric efficiency of the hydrogen storage practice.

In some embodiments of the invention water may be provided by the use of hydrated hydroxide particles. In such embodiments, a portion of the hydride material reacts with the water to generate hydrogen, a hydroxide, and heat for further hydrogen production reactions. Another portion of the hydride content reacts with the formed hydroxide and still more hydride particles react with the original hydroxide. Hydrogen and a solid oxide are produced by reaction of mixed hydride particles and hydroxide particles. In preferred embodiments, the hydride starting material and hydroxide material are substantially consumed in such production of hydrogen.

No reference teaches or suggests the invention recited in any of the claims in this application.

The Claim Rejections

The Amendola et al. published patent application (hereafter Amendola for brevity) is applied alone or as the primary reference in rejection of each pending claim in this application. Amendola describes the release of hydrogen from an aqueous solution of lithium borohydride (or other metal hydride) by reaction of the borohydride with water. A small amount (not a chemically equivalent amount) of a metal hydroxide is dissolved in the aqueous solution to stabilize the hydride until it is desired to heat the solution to overcome such hydroxide stabilization and promote the reaction of the hydrides with water. Water is a necessary reactant in the Amendola reaction scheme. The focus of the Amendola disclosure is on the catalysis and management of this aqueous based hydrogen production system.

The Amendola disclosure certainly does not disclose or contemplate a solid state reaction between a mixture of particles of a hydride and a hydroxide for the production of hydrogen. Amendola does not employ a reaction between a limited quantity of water and a portion of a hydride content to promote a solid-state reaction in a mixture of hydride particles and hydroxide particles. Amendola does not produce a solid oxide product. And Amendola does not disclose a solid state reaction between substantially chemically equivalent portions of such hydride and a hydrated hydroxide in the release of hydrogen from hydrogen storage materials and the co-production of a solid oxide.

Amendola does not anticipate any of claims 1-12, 14-18, 48, 49, 67-71 nor does the Amendola disclosure render them obvious. These rejections should be withdrawn.

The Chen et al patent (U.S. 6,471,936) is combined with Amendola in rejection of claims 26-29. Chen is cited as disclosing the use of LiH and LiOH in hydrogen storage. But Chen discloses lithium-doped nanotubes for hydrogen storage. Chen does not contemplate a reaction between his lithium compounds to release hydrogen. He uses one or more such compounds to dope carbon nanotubes so that the nanotubes will take up hydrogen. But Chen does not promote a reaction between particles of lithium hydride and lithium hydroxide to produce hydrogen. Thus, the Chen concept is entirely different from the claimed inventions. No combination of Amendola and Chen can be said to disclose applicants' solid state reaction system. The rejection of claims 26-29 should be withdrawn.

Amendola is combined with the Machin et al publication or the Long et al patent in rejection of claims 19-25, 54-55, 61, 63-66, 72-81.

Machin et al introduce water vapor into particles of lithium hydride and observe many different products depending on the amount of water added. Hydrogen is produced as are different combinations of lithium hydroxide, lithium oxide. A reaction between hydrated lithium hydroxide and lithium hydride is stated as a simplification of several possible interactions between the water and lithium hydride. But Machin et al do not disclose or contemplate the use of water for reaction with a portion of hydride particles for promoting a hydrogen producing reaction in a mixture of additional particles of lithium hydride and lithium hydroxide as recited in applicants' claimed methods. Machin does not contemplate the use of a hydrated hydroxide as a source of such water for such purpose. Machin observes diverging and competing reactions between water and lithium hydride and byproducts but certainly does not disclose or suggest the use of water or hydrated lithium hydroxide as specified in the rejected claims. And there is no logical technological connection between the Amendola publication and that of Machin et al that makes obvious applicants' claimed methods. This rejection should be reconsidered and withdrawn.

The Long patent discloses adiabatic hydrolysis and thermal decomposition of hydrides to form hydrogen. Reactions between hydrides and hydroxides for this purpose are not promoted. A quantity of metal hydride must be heated to a temperature for an exothermic reaction between the hydride and water to form hydrogen and a metal oxide with the release of

heat. The heat is used in an adiabatic environment to induce the thermal decomposition of other metal hydride content to produce hydrogen. Long observes that undesirable metal hydroxides and hydrates may be produced. In the insulated container of the Long practice these hydrates and hydroxides may decompose generating unwanted steam for uncontrolled reaction with hydrides in the container. Long seeks to control his hydride-focused process to minimize the formation of hydrates and hydroxides. But applicants claimed methods make good use of generally chemically equivalent amounts of hydrides and hydroxides and hydrates to produce hydrogen. Applicants' method includes a solid state reaction involving a hydride and a hydroxide to form hydrogen.

The Long teaching and concern does not suggest applicants claimed methods for using controlled amounts of water to promote a hydrogen producing reaction between metal hydrides and hydroxides. For example, independent claim 72 states that the proportions of hydride particles and hydrated hydroxide particles are chemically equivalent to the water content and hydroxide content of the hydrated hydroxide. This practice is not disclosed in any of Amendola, Machin, or Long or any combination of them.

The Long disclosure is unrelated to the Amendola publication. And the combination of Long with Amendola doesn't suggest mixture of hydrated hydroxides and hydroxides in promoting a hydrogen producing reaction between mixtures of particles of hydrides and hydroxides. This rejection, too, should be reconsidered and withdrawn.

Amendola is combined with Chen and either Machin or Long in rejection of claims 57, 82, and 84. As stated above, these references are not sufficiently related to be combined in rejections of any of applicants' claimed methods. The combination of references does not make obvious the methods recited in independent claims 1 and 72 and do not make obvious dependent claims 57, 82, and 84. This rejection should be reconsidered and withdrawn.

For the reasons stated, it is requested that the rejections of claims 1-12, 14-29, 48, 49, 54, 55, 57, 61, 63-82, 84, and 88 be reconsidered and withdrawn. Since independent claims 1, 67, and 72 are believed to be patentable, it is also requested that the withdrawn claims also be considered in this application and that they be allowed.

If there are unresolved issues concerning this application that could be discussed, the Examiner is invited to call applicants' attorney at the number provided below.

Respectfully Submitted,

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